METHOD OF TEST FOR
DETERMINATION OF V.M.A.
IN COMPACTED BITUMINOUS MIXTURES

1. SCOPE

1.1 This method covers the calculations required to determine the Voids in Mineral Aggregate (V.M.A.) of a compacted bituminous mixture.

2. RELEVANT DOCUMENTS

2.1 MTO Methods LS-262, LS-604, LS-605

3. DEFINITIONS

3.1 V.M.A. in a thoroughly compacted paving mixture consists of the volume of intergranular void space between the aggregate particles that includes the air voids and the effective asphalt content expressed as a percentage by volume of the total volume of the sample.

4. CALCULATIONS

4.1 V.M.A. (Figure 1)

$$\text{V.M.A.} = \frac{G_b - G_c}{G_b} \times 100$$

$$= 100 - \frac{D_b(100 - \%\text{ A.C.})}{G_b}$$

$$\text{where } G_b = \frac{100}{\frac{\%\text{ Co. Agg.}}{\text{BRD Co. Agg.}} + \frac{\%\text{ Fi. Agg. \#1}}{\text{BRD Fi. Agg. \#1}} + \frac{\%\text{ Fi. Agg. \#2}}{\text{BRD Fi. Agg. \#2}} + \ldots}$$

$$\text{and } G_c = \frac{Db \times (100 - \%\text{ A.C.})}{100}$$

G_b = bulk relative density of aggregate

G = compacted relative density of aggregate

D_b = bulk relative density of compacthe plant check gradation and A/

BRD = bulk relative density (LS-604 & LS-605)

5. REPORTING OF RESULTS

5.1 Report V.M.A. in % to nearest 0.1% on the Bituminous Mix Form, (see Figure 2).

6. NOTES

6.1 If the plant check gradation and AC content is very close to the mix design, then the G_C calculation from the mix design may be used.

6.2 If the plant check gradation varies by 5.0% or more from the design, then the BRD's for the coarse and fine aggregates must be used to calculate the V.M.A. Both the G_C calculation and the BRD's for the coarse and fine aggregate(s) should be noted in the remarks column of the Bituminous Mix Design Report (Figures 3,4; Respectively, front and back sides of report.).

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% VOIDS IN MINERAL AGGREGATE

DATE______________________ CONTRACT No______________________

MATERIALS

MATERIALS	LAB No.	B.R.D.	WATER ABSORP.
RECLAIM ASPHALT PAV'T. (R.A.P.)			
COARSE AGGREGATE			
COARSE AGGREGATE PASS #4.75mm			
FINE AGGREGATE # 1			
FINE AGGREGATE # 2			
MINERAL FILLER			

MIXES SELECTED

		1	2	3	4
% R.A.P.					
% CO. AGG.					
% FINE AGG. # 1					
% FINE AGG. # 2					
% M.F.					
% A.C.	1				
	2				
	3				

CALCULATIONS

1. BULK RELATIVE DENSITY OF COMPACTED MIX (D_b)

1	2	3	4

2. BULK RELATIVE DENSITY OF AGGREGATE (G_b)

$$\frac{100}{\frac{\%Co.\ AGG.}{B.R.D.\ Co.\ AGG.}+\frac{\%Fi.\ AGG.\#1}{B.R.D.\ Fi.AGG.\ \#1}+\frac{\%Fi.\ AGG.\#2}{B.R.D.\ Fi.AGG.\#2}+.........}$$

1	2	3	4

3. VOIDS IN COMPACTED AGGREGATE (V.M.A) %

$$\%V.M.A = 100 - \frac{D_b\left(100 - \%\ A.C.\right)}{G_b}$$

1	2	3	4

PH-CC-372 (Formerly OBMT153)

Figure 1

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BITUMINOUS MIX FORM

PROPERTY		SAMPLE NUMBER			AVERAGE
A_1	MASS OF COMPACTED SPECIMEN IN AIR				
A_2	SURFACE DRY MASS OF SPECIMEN IN AIR AFTER IMMERSION IN WATER				
B_1	MASS OF COMPACTED SPECIMEN IN WATER				
B_2	VOLUME = A_2-B_1				
C	*** BULK RELATIVE DENSITY = A_1/B_2				
D	MASS OF FLASK AND MIXTURE IN AIR				
E	MASS OF FLASK IN AIR				
F	MASS OF MIXTURE IN AIR = D - E				
F_1	*SURFACE DRY MASS OF MIXTURE IN AIR*				
G	MASS OF FLASK AND MIXTURE IN WATER				
H	MASS OF FLASK IN WATER				
I_1	MASS OF MIXTURE IN WATER = G - H				
I_2	VOLUME = F - I_1				
I_3	* S.D. VOLUME = F_1 - I_1				
J	* MAXIMUM RELATIVE DENSITY = F / I_2				
J_1	*** S.D. MAXIMUM RELATIVE DENSITY = F / I_3				
K	PERCENT VOIDS IN MIXTURE = $\frac{J - C}{J} \times 100$				
K_1	*SD. PERCENT VOIDS IN MIXTURE = $\frac{J_1 - C}{J_1} \times 100$				

MARSHALL TEST VALUES

PROPERTY	SAMPLE NUMBER			AVERAGE
STABILITY (DIAL)				
FLOW No 1 (s)				
FLOW No 2 (s)				
AVERAGE FLOW (s)				

VISUAL OBSERVATIONS

MIX APPEARANCE		D,M,R,VR
BRIQUETTE APPEARANCE		D,M,R,SF,F
COATING	F.AGG / C.AGG.	P,F,G / P,F,G
STRIPPING		NIL,SL,M,H
C.AGG.FRACTURE		NIL,SL,M,H
WETNESS OBSERVED IN FRACTURED C.A. ****	Y	N

CONTRACT No______________________

DATE______________________

SAMPLE No.______________________

Remarks: ______________________

____

* S.D. MEANS SURFACE DRY
** V.M.A CALCULATED ON % VOID IN MINERAL AGGREGATE FORM
*** ALL RELATIVE DENSITIES ARE CORRECTED TO 25^{O}C
****INDICATE BY CIRCLING Y FOR YES OR N FOR NO

SUMMARY OF TEST RESULTS

VOID (%)		*S.D
FLOW (.25mm)		
CORRECTED STABILITY (N)		
** V.M.A. (%)		

MIX TYPE______________

%A.C______________

%PASS 4.75mm__________

Blend__________S.D ☐

	AGGREGATE SAMPLE NO.
C/A	
SAND	
SA/SCR	
RAP	

PN-CC-351 93-02

FIGURE 2

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BITUMINOUS MIX DESIGN REPORT

CONTRACT No.		HOT MIX TYPE / USE		ITEM No.	
HWY.		LOCATION			
TESTING LAB.		JOB MIX FORMULA No Issued by Qual. Assurance			
LAB MIX No.		DATE SAMPLES REC'D.			
		DATE COMPLETED			

TEST DATA CERTIFIED BY:_______________________________

JOB MIX FORMULA- GRADATION PERCENT PASSING *

%AC	26.5	19.0	16.0	13.2	9.5	4.75	2.36	1.18	600	300	150	75

MARSHALL		REQUIREMENTS	SELECTED
	(min.)		
	(max.)		
FLOW (min.)			
STAB (min.)			
% VMA (min.)			

% CA #1	
% CA #2	
% FA #1	
% FA #2	
% FA #3	
Gb	

% RAP	
% AC RAP	
RAP PEN	
BRIQ. BRD	
MRD	
MRD (SD)	

ASPHALT CEMENT	
SUPPLIER	PENETRATION

ADDITIVE		
SUPPLIER	TYPE	AS % OF AC

AGGREGATE TYPE	SOURCE / INVENTORY No.	AGGREGATE TYPE	SOURCE / INVENTORY No.
COARSE AGG #1		FINE AGG #2	
COARSE AGG #2		FINE AGG #3	
FINE AGG #1		RAP	

AGGRE -GATE TYPE	BULK RELATIVE DENSITY	ABSORP -TION	AGGREGATE GRADATION- PERCENT PASSING											
			26.5	19.0	16.0	13.2	9.5	4.75	2.36	1.18	600	300	150	75
RAP CA														
RAP FA														

*FINES RETURNED TO THE MIX (%)
REMARKS:____

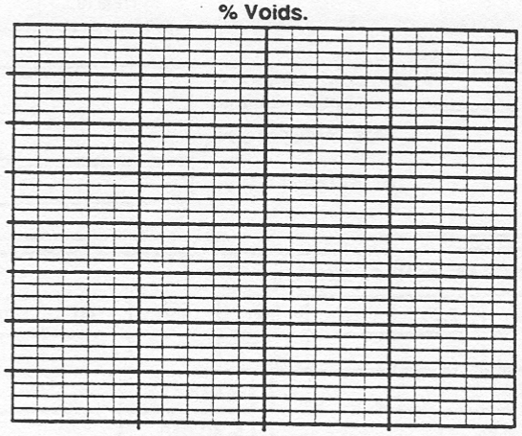
PH-CC-353 8804 REVIEWED BY:____________________ (MTO) DATE:______________________

FIGURE 3

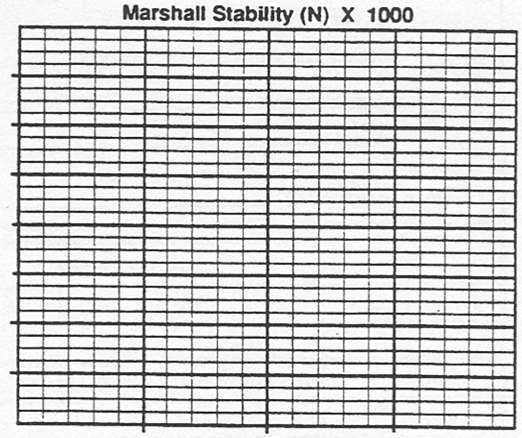
BITUMINOUS MIX DESIGN: Contract No. ____________ Mix Type / Use ____________

Lab Mix No. ____________

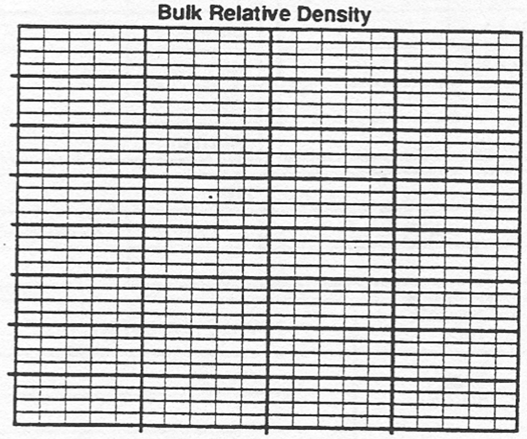
% Voids.



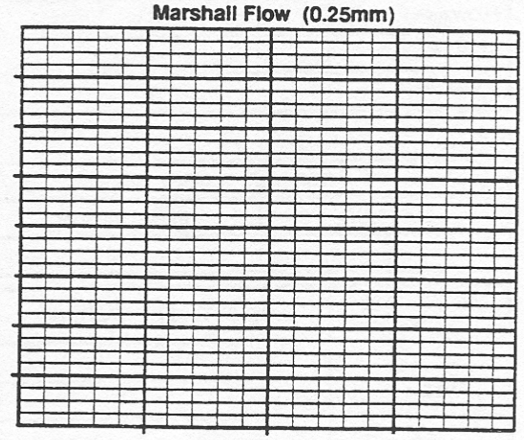
Marshall Stability (N) X 1000



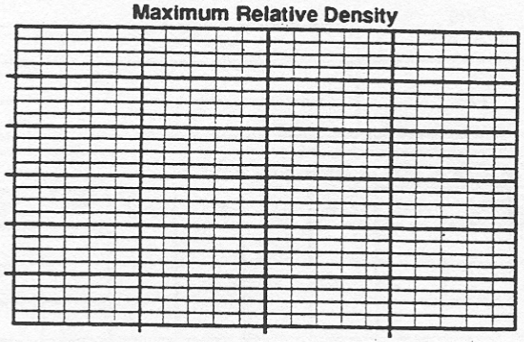
Bulk Relative Density



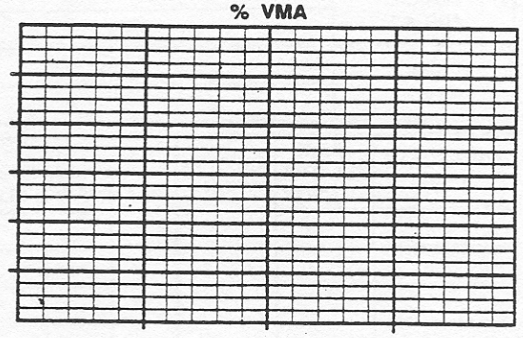
Marshall Flow (0.25mm)



Maximum Relative Density



% VMA



A.C. %

A.C. %

VISUAL OBSERVATIONS: ____________

Figure 4